AP2. APPENDIX 2

OPERATIONAL FIELD STORAGE

1. **General**.

This appendix has been prepared to specifically address ammunition and explosives (AE) operational storage in the field. It is applicable to all AE storage scenarios in the field environment and is meant to support the application of criteria in DoD 6055.09-STD, in particular for reduction of maximum credible event (MCE) and associated quantity distance (QD) criteria. The information contained herein is derived from DoD 6055.09-STD, from elsewhere in DDESB TP15, and from select DDESB approval memoranda and has been consolidated into this appendix to assist operational field storage personnel.

The objectives of Appendix AP2 are to:

1. Provide an overview of AE explosion effects from which to protect against so as to prevent prompt propagation (the foundation for minimizing MCE).

2. Provide a discussion of the methods that can be used for minimizing MCE and its associated QD.

3. Provide specific information on techniques and construction methods that have been approved by the DDESB for the reduction of MCE and QD.

Appendix AP2 will be kept current and can be obtained from the DDESB's webpage: http://www.ddesb.pentagon.mil.

Metric equivalents are provided where feasible within AP2. The metric values will be found within brackets [ ] and are highlighted.

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2. **Operational Field Storage**.

This type of AE storage is typically conducted outside Continental United States (OCONUS) on designated real estate either provided by a host nation or obtained as part of movement through enemy territory. In most cases, insufficient land is provided to meet criteria of DoD 6055.09-STD and DoD Component explosives safety criteria. A basic rule relating to AE storage is that when minimum required intermagazine (IM) separation distances cannot be met between storage sites containing munitions, then the net explosive weight (NEW) associated with all AE in the deficient sites must be summed together and will form the basis for QD. This will greatly increase the amount of real estate required and will likely have a corresponding increase in risk to DoD personnel and the public. The fundamental rule for efficient and safe AE storage is to meet minimum IM separation distances and reduce the MCE to the smallest quantity of AE possible. This will reduce the risk to DoD personnel and operations, reduce the risk to the public, and reduce required QD and the amount of real estate needed to accommodate the QD arcs. The methods and techniques provided below will assist in minimizing the MCE and reducing QD.

3. **QD – K factors**.

In DoD 6055.09-STD, net explosive weight quantity distance (NEW) is used to calculate QD by means of a formula of the type D (ft) = $K{\bullet}W^{1/3}$, where "D" is the distance in feet, "K" is a factor (also called K-factor) that is dependent upon the risk assumed or permitted, and "W" is the NEW in pounds. When metric units are used, the symbol "Q" denotes Net Explosive Quantity (NEQ) in kilograms. In the formula D (m) = $K_m{\bullet}Q^{1/3}$, the distance "D" is expressed in meters. Thus, the respective units of "K" are ft/lb$^{1/3}$ and " K_m " are m/kg$^{1/3}$ in the two systems. The value of "K" in English units is approximately 2.52 times " K_m." For example, if D (m) = $6{\bullet}Q^{1/3}$, then D (ft) = $15.12{\bullet}W^{1/3}$. Distance requirements determined by the formula with English units are sometimes expressed by the value of "K," using the terminology K6 [2.38], K9 [3.57], K11 [4.36], K18 [7.14], to mean K=6, K = 9, K = 11, and K = 18. This same terminology is used in this appendix.

4. **QD Principles**.

Hazardous effects produced by an AE explosion generally consist of airblast, fragments (primary and secondary), and thermal. Given sufficient distance from the explosion source, these effects can eventually be reduced to a point where the worst hazard of consideration no longer presents any risk. However, the use of large protective zones is typically not acceptable because of the vast quantities of real estate that would be needed. Consequently, explosives safety criteria of DoD 6055.09-STD specify a minimum required default separation distances for the prevention of propagation (prompt and subsequent) and for the protection of personnel (related and non-related) and assets, after consideration of the type of AE operation being conducted, the protection level required, the AE involved, the type of facilities involved, as well as other factors. DoD 6055.09-STD permits the use of lesser separation distances if DDESB approved protective construction/mitigation is used that is capable of providing an equivalent level of protection to that required at the minimum default separation distance. Testing and/or analyses are typically necessary to demonstrate to the DDESB that the mitigation method selected is equivalent and/or adequate.

Conditions and restrictions (e.g., maximum NEW, minimum standoff distances, minimum barricade height, required construction materials) apply to the use of protective construction and mitigation methods/designs. These conditions and restrictions ensure that any planned use of the method/design falls within the boundaries and parameters that were defined by testing or analyses. Use of one of the methods/designs discussed in this appendix outside of its established boundaries and parameters may yield a different result from that tested and could negate the benefit that was intended. Consequently, it is extremely critical that before a method/design is selected, that all pertinent information and approvals be obtained, read and understood, and all conditions and restrictions followed. Additional testing or analyses may be conducted if there is an interest in evaluating other applications and uses for a specific method/design.

5. **Sensitivity Group (SG) Concept**.

The application of the SG concept considers the applied unit impulse and energy loads on acceptor AE in order to prevent sympathetic detonation (SD). Through testing, parameters have been defined for SD that are based on (a) unit impulse loads, (b) the unit kinetic energy of the "non-propagating wall (NPW)" in use, and (c) the NPW's velocity as it moves away from the explosion source. These 3 elements must be less than or equal to established threshold limits of the acceptor AE in order to prevent SD. When the SG concept is appropriately applied to the storage of two stacks of AE separated by a NPW, the MCE is the NEWQD associated with the largest stack of AE.

The five SG, in relative order from least sensitive to most sensitive, are:

1. **SG 2**: Non-robust or thin-skinned AE.

2. **SG 1**: Robust or thick-skinned AE. A SG 1 item meets any two of the following criteria:

a). Ratio of explosive weight to empty case weight < 1.

b). Minimum case thickness > 0.4 inches [1 cm].

c). Ratio of case thickness to NEWQD$^{1/3}$ > 0.05 in/lb$^{1/3}$ [0.165 cm/kg$^{1/3}$].

3. **SG 3**: Fragmenting AE. These items, which are typically air-to-air missiles, have warhead cases designed for specific fragmentation (e.g., pre-formed fragment warhead, scored cases, continuous rod warheads, etc.).

4. **SG 4**: Cluster bombs/dispenser munitions.

5. **SG 5**: Other AE (items for which HPM non-propagation walls are not effective). Items are assigned to SG 5 because they are either very sensitive to propagation or their sensitivity has not been determined.

All U.S. hazard division (HD) 1.1 and 1.2 munitions have been assigned an SG designation. Directed energy weapons are further identified by assigning the suffix "D" following the SG designation (e.g., SG2D). The SG assigned to a U.S. HD 1.1 and HD 1.2 munition can be found in the Joint Hazard Classification System (JHCS).

The SG concept is used with several approved barricade configurations described below. Use conditions associated with each design must be closely followed in order to obtain the expected MCE. Violation of use conditions could jeopardize the entire storage site and increase the QD from that initially planned for.

6. **Munition Effects to Protect Against**.

In a field storage environment, HD are generally mixed as necessary to accomplish the mission. Storage compatibility requirements are met to prevent unauthorized mixing of munitions and to minimize risk in the event an accident occurred. However, in certain situations involving quantities less than 8,820 lbs [4,000 kg], compliance with storage compatibility requirements are not mandated, and field units are permitted to mix HD and compatibility group (CG). The primary AE effects that need to be addressed, in terms of reducing MCE and minimizing QD, are airblast, fragments (primary and secondary (includes debris)), and thermal. Each of these effects presents a unique hazard to nearby structures and personnel, and AE storage, and must be considered accordingly. A short discussion of each AE effect is provided below.

Airblast. In an explosion, the violent release of energy creates a sudden and intense pressure disturbance termed the "blast wave." The blast wave is characterized by an almost instantaneous rise from ambient pressure to a peak incident pressure. This pressure increase, or "shock front," travels radially outward from the detonation point, with a diminishing velocity that is always in excess of the speed of sound in that medium. As the pressure wave expands away from the detonation source, there is an associated reduction in the pressure associated with the front. The duration of the front is proportionally related to the amount of AE that contributed energy to the detonation (i.e., smaller amounts of AE have a smaller QD, while larger amounts of AE have a larger QD associated with them). An additional hazard associated with airblast is the translation of energy to nearby AE that was not part of the initial explosion, such as AE in an adjacent storage module. The airblast could propel a barricade against the AE in the adjacent cell and cause a reaction in the AE, or the AE could be picked up by the airblast and propelled against other AE or against a hard surface, which causes a reaction of the AE involved).

Fragments: An important consideration in the analysis of the hazards associated with an explosion is the effect of any fragments produced. Although most common in HD 1.1 or HD 1.2 (see below) events, fragmentation may occur in any incident involving AE. Depending on their origin, fragments are referred to as "primary" or "secondary" fragments.

1. Primary fragments result from the shattering of a container (e.g., projectile or bomb casings) in direct contact with the explosive. These fragments usually are small, initially travel at thousands of feet per

second and may be lethal at long distances from an explosion. (NOTE: The high-speed, low-angle fragments present a very high risk of propagation to adjacent AE storage.)

2. Secondary fragments are debris from structures and other items in close proximity to the explosion (e.g., barricades, ISO containers, overhead protection, sandbags). These fragments, which are somewhat larger in size than primary fragments and initially travel at hundreds of feet per second, do not normally travel as far as primary fragments.

Thermal. Generally, thermal hazards from a HD 1.1 or HD 1.2 event are of less concern than airblast and fragment effects. The reason for this is that it normally takes longer to incur injury from thermal effects than from either blast or fragmentation effects because both blast and fragmentation occur almost instantaneously. Conversely, when the accident involves a fire, the time available to react to a thermal event increases survivability. The primary thermal effect on structures, material, and AE is their partial or total destruction by fire. The primary concern with a fire involving AE is that it may transition to a more severe reaction, such as a detonation.

7. **Reducing MCE**. The MCE is the worst single event that is likely to occur from a given quantity and disposition of AE. As mentioned previously, reducing the MCE will permit a reduction in QD because the effects by a lower MCE explosion will generally be less severe. Once determined, the MCE can be used as the basis for determining required QD. There are a number of ways to accomplish MCE reduction and those are discussed below:

Distance. If K11 [3.57] distance is provided between unbarricaded, aboveground storage sites, then the MCE can be considered to be the amount of AE at each location. The problem with use of distance alone is that it requires vast quantities of real estate to provide the required K11 separation distances, basically making it unfeasible for many storage scenarios. K11 [3.57] is directly proportional to the amount of explosives present, so the required separation distance will be reduced as the AE quantity is reduced. Required distances can be further reduced by the use of barricades as discussed below, or through testing that successfully demonstrates that certain munition configurations (e.g., robust bombs and projectiles or missiles aligned a certain way) will not simultaneously detonate at lesser distances due to their design, alignment, configuration, or other mitigating circumstances.

Separation by barriers, barricades, or other similar fragment defeating protective construction. Fragments, primarily high-velocity, low-angle primary) present the greatest threat towards causing prompt (or near-simultaneous) propagation of an explosion to adjacent AE storage. Fragment defeating protective construction can be used to stop fragments or reduce their speed to a point where they no longer present a risk to the adjacent AE storage. When this is accomplished and a test demonstrates that the overpressure also does not present a prompt propagation hazard to adjacent AE, then the MCE is largest amount of AE present.

This is the basis for the default application of aboveground, barricaded, intermagazine separation distance (K6) [2.38] between stacks of explosives separated by a barricade meeting minimum criteria. The overpressure at this distance is not sufficient to cause simultaneous detonation of even the most sensitive AE, and a barricade protects the AE from high-velocity, low-angle fragments (see below), thereby preventing prompt propagation. When backed up with supporting test data, separation distances between specific storage configurations and scenarios this distance can be further reduced, in some cases significantly. This is described further in the next section.

Justifying Further Reduced Distances. Certain storage scenarios have been proven, through testing, to prevent prompt propagation at significantly reduced separation distance, far less than K6 [2.38]. These scenarios include some with barricades and some without barricades. In all cases, the DDESB approvals are very specific regarding the conditions and limitations that must be followed. Those scenarios approved by the DDESB are documented below. Because it would take up to much room, it is not possible to identify all conditions associated with each configuration. Therefore, a general summary is provided, along with the reference document, which is available from the DoD Component identified or from the DDESB.

8. Barricade Discussion.

Removal of 2-degree barricade height requirement. In 2006, the DDESB approved (reference DDESB-PD Memo of 11 Dec, Subject: Approval of Change to DoD 6055.09-STD, Barricade Design Requirements) a change to the barricade design requirements of reference 1-1, specifically for determining the required height of barricades used for protection against prompt propagation due to high-velocity, low-angle fragments. The then existing "2 degree rule" was replaced with a requirement that the barricade's height must be at least one foot above the line-of-sight between explosives stacks, with the line-of-sight determined in the same manner as was previously required. Details regarding this change can be found in the DDESB approval document. [**NOTE**: This change does not apply to previous approvals where explosion testing was conducted with a barricade (e.g., Air Force Big Papa test for barricaded module storage described in Chapter 7), where the tested barricade's height was determined using the two-degree requirement.] Details regarding this change can be found in the DDESB approval document.

Barricades are available in many different shapes and sizes and can be used for a number of different purposes. The various uses of a barricade are described below:

1. A barricade can provide an effective means of stopping high-velocity, low-angle fragments that are the primary cause of prompt propagation of an explosion from one AE storage site to another AE storage site. In the event of an explosion at one of

these sites, the presence of a barricade will not necessarily prevent subsequent explosions from occurring at other nearby sites; however, each explosion may be viewed as a separate event.

2. A barricade can provide adjacent operations and facilities protection from high-velocity, low-angle fragments, which present a high risk of injury or death to personnel, and a high damage potential to facilities and equipment. A barricade will not provide any protection from high-angle fragments, which can pass over a barricade.

3. A barricade can provide limited protection from blast overpressure, in an area immediately behind the barricade. The amount of protection provided by a barricade is governed by the barricade's height and width and the distance the exposure is from the rear of the barricade. Protection increases as separation distance decreases. A barricade is ineffective in reducing blast overpressure at far-field distances, such as those associated with inhabited building or public traffic route distances.

4. In certain situations, explosives safety criteria permit the use of reduced separation distances between explosives sites and from explosives sites to adjacent operations and facilities, when properly constructed, intervening barricades are present.

5. Some barricades are designed for specific applications, such as to contain fragments or to minimize potential fragment throw distances. Examples where such barricades could be used are at an ordnance environmental (OE) cleanup site, to protect from an unintentional detonation of an AE item being worked, or at an EOD site where only limited quantities of explosives material will be detonated/burned. Use of such fragment defeating barricades may permit a reduction in QD, by allowing other factors, such as blast overpressure or maximum expected fragment distance, to govern the application of QD.

6. When there is a need for AE to be in close proximity to other AE, a barricade can be used to limit the MCE to a single AE item, stack, vehicle, etc. As a result, the QD arc emanating from the site can be reduced because it is based on the MCE involved and not all the AE on-site.

9. **Approved Barricade Designs**.

Drawing DEF 149-30-01. The Huntsville Division of the U.S. Army Corps of Engineers has developed a definitive drawing, DEF 149-30-01, which provides construction information for numerous barricade designs that can be used to protect facilities and equipment located close to explosives sites from high-velocity, low-angle fragments. The definitive drawing provides details for the construction of the traditional earthen barricade, sandbag barricades, numerous retaining wall barricades, and other types of barricades. The various barricade configurations are recognized as effective for the applications shown on the drawings and, consistent with constraints indicated on the drawings, are approved for site-adaptable implementation. The drawing can be obtained from the DDESB web site. **NOTE**: Regarding the earth-sloped barricade; Refer to Section C5.3 of DoD 6055.09-STD for criteria associated with determining barricade height and length.

Barricaded Open Storage Modules. As depicted in Figure C5.F1. of DoD 6055.09-STD, a module is a barricaded area composed of a series of connected cells with hard surface (e.g., concrete, packed earth, engineered materials, etc.) storage pads separated from each other by barricades. Although a light metal shed or other lightweight fire retardant cover may be used for weather protection for individual cells, heavy structures (e.g., reinforced concrete, dense masonry units) or flammable material shall not be used. The barricade prevents prompt propagation, therefore, the MCE is one module. The following apply to use of a barricaded open storage module (**NOTE**: All references to paragraphs, sections, figures, and tables pertain to DoD 6055.09-STD.):

1. The maximum NEW permitted to be stored within each cell is 250,000 lbs (113,398 kg).

2. Module storage is considered a temporary expedient and may be used as the DoD Component concerned determines necessary. However, from an explosives safety and reliability standpoint, priority shall be given to the use of ECM for items requiring protection from the elements, long-term storage, or high security protection.

3. Storage shall be limited to AE that will not promptly propagate explosions or mass fire between modules, and that are not susceptible to firebrands and fireballs. These restrictions allow storage at K1.1 [0.44] separation.

a. Only the following AE are approved for modular storage:

1. Robust HD 1.1 AE (e.g., HE bombs, fuzed or unfuzed, with or without fins) when stored on nonflammable pallets.

2. The below items when contained in nonflammable shipping containers:

a) 30 mm and smaller AE.
b) CBU.
c) Inert AE components.
d) HD 1.4 AE.

b. Module storage of AE items in flammable outer-packaging configurations shall be minimized. AE items in flammable outer packaging configurations must be covered with fire retardant material. Combustible dunnage or other flammable material shall not be stored either in, or within, 100 ft (30.5 m) of modules.

c. When fire retardant materials are used to cover AE items stored in modules, ventilation shall be provided between the covers and the stored AE items to minimize the effects of solar heating upon the stored AE.

d. AE stored in each module shall normally be limited to one type of item, unless the DoD Component concerned authorizes mixed storage.

4. Barricade Requirements: Barricades used in forming the module shall meet the requirements in section C5.3.. The width or length of the stack of AE (controlled by the pad size of the cell) and the distances between the stack and the top of the barricade influences the minimum barricade height requirement. The heights listed in Table C5.T1. are the minimum requirements for barricade locations. These minimum heights are based upon both the storage pad sizes and the separations shown. When feasible, barricade heights should be increased (see subparagraph C5.3.2.3.).

Jungle Growth. Dense vegetation can be effective in preventing prompt propagation of an explosion from one explosives site to another, due to the jungle growth's ability to stop high-velocity, low-angle fragments. The density of jungle growth plays an important role in stopping these fragments. On 27 July 1976, the DDESB approved the use of barricaded, aboveground separation distance (K6) [2.38] between aboveground, unbarricaded explosives storage sites at Andersen Air Force Base, Guam. Their approval was based on testing which showed that high-velocity fragments could be effectively stopped by a medium that had a gross average density of at least 2000 grains/ft^3 [4.58 kg/m$^{1/3}$], about four times the density of air at standard conditions. The DDESB approved restricted use of jungle growth as an effective barricade for the storage of relatively insensitive, finished ammunition, such as bombs and separate-loaded projectiles, without fuzes or propelling charges. In addition, a regular program of surveillance is required to insure that the average gross density of the jungle growth does not become diminished.

Earth-filled, Steel Bin-Type Barricades. These barricades, also known as ARMCO Inc. revetments, are earth-filled, steel bins that have been used to separate munitions awaiting scheduled processing; for example, munitions on flight lines associated with aircraft parking/loading operations, or the temporary positioning of munitions awaiting transfer to preferred, long-term storage. These barricades are also used to separate uploaded aircraft. These barricades are typically formed into cells and are designed to limit the MCE (for QD purposes) to the munitions stored in each cell. Reference AP2-1 documents the work accomplished to evaluate the ability of the ARMCO revetment to prevent sympathetic detonation.

Armco Inc. revetments cells are approved for storage of any HD 1.1 and HD 1.2 AE assigned to SG 1 through 4. In addition, storage of HD 1.3, HD 1.4, or HD 1.6 items is approved.

When properly sited, these cells prevent prompt detonation transfer; however; all assets in the series of cells are at risk of loss. Although a revetment is effective in limiting the blast loading of an adjacent ES to that produced by the largest contents of a single cell, there is a significant probability that the contents of many of the cells will be damaged or destroyed by the initial and subsequent fire and explosion events. The extent of such losses increases with the amount of explosives present.

Two types of steel-bin barricades have been approved for airfield applications:

1. Type A revetments, which must be a minimum of 7 feet [2.1 m] thick, can be used to limit a MCE in a series of cells to the largest quantity in any single cell, provided the NEW in any single cell does not exceed 30,000 pounds [13,608 kg].

2. Type B revetments, which must be a minimum of 5.25 feet [1.6 m] thick, can be similarly used to limit the MCE, provided no cell contains more than 5,000 [2,268 kg] pounds NEW .

<u>ARMCO Use Conditions</u>:

1. The barricade height and length criteria shown in Figure C5.F3.

2. AE shall be positioned no closer than 10 feet [3.1 m] from cell walls, no closer than 3 feet [0.9 m] from the end of the wing walls, and no higher than 2 feet [0.6 m] below the top of cell walls.

3. AE shall be distributed over the available area within the cell, rather than being concentrated in a small area.

4. AE stored in a cell in quantities near the maximum NEW limit shall not be configured into a single row of pallets, stacks, or trailers.

5. The storage of AE in flammable outer-pack configurations shall be minimized.

<u>Ammunition Quickload and Safeload Programs</u>. These programs were developed by the U.S. Army Project Manager for Ammunitions Logistics, in response to a 1986 DDESB Survey of U.S. Army camps in Korea, which revealed that a number of explosives safety storage violations (primarily involving explosives loaded vehicles) existed in proximity to occupied areas. These programs, through testing, developed barricades to help reduce MCE to smaller NEW that were more manageable and that permitted reductions in QD. These barricades were intended to be used primarily in Theatres of Operation. The following barricades were developed under these programs:

1. **<u>Agan Steel Panel (ASP) Walling System</u>**. The ASP Walling System consists of formed metal sheets, which are joined together to constitute both the permanent framework for the wall and the reinforcement for the concrete that is then

poured into the metal framework and allowed to cure. Reference AP2-2 is the revised TDP for the ASP Walling System and it details the construction techniques that are required to properly assemble the ASP Walling System. The system permits the parking of 155mm loaded trucks, carrying up to one hundred and sixty (160) 155mm projectiles (M107 or M483) and their associated propellant charges, side-to-side with an intervening ASP Walling System between trucks. This quantity of 155mm projectiles equates to NEW of about 2,500 pounds [1,134 kg]. A minimum of 15 feet [4.57 m] must separate trucks. In this configuration, the MCE is the AE on one truck, and QD can be based on this MCE.

2. **<u>Sand Grid Wall</u>**. The Sand Grid Wall uses commercially available honeycomb grid sections that are expanded and sand-filled, in accordance with the instructions provided in reference AP2-3, to construct the barricade needed. Once built up to the required height, the sand grid wall can be used as a barricade to separate individual truck or trailer loads of 155mm artillery projectiles plus their associated propellant charges. Up to one hundred and sixty (160) 155mm projectiles and their associated propellant charges, may be on any truck or trailer, which represents the MCE for QD purposes. A minimum separation distance of 15 feet [4.57 m] must be maintained between trucks or trailers. Initial DDESB approval for the Sand Grid Wall was granted on 22 February 1991, for use as a barricade for twenty-one (21) different projectile types and their associated propellant charges. Subsequent DDESB approval for an additional four projectiles and their propellant charges was granted on 24 June 1991. The total number of projectile types permitted to use the Sand Grid Wall barricade is currently twenty-five (25).

3. **<u>Geotextile Stabilized Sand Walls as Barricades</u>**. A 6 February 1991 DDESB memorandum found acceptable the concept of a stand-alone, geotextile stabilized sand wall barricade, which was at least three feet [0.91 m] thick at its crown, provided it could meet lifetime requirements through validated erosion control techniques. This barricade design had to have side slopes exceeding 1.5 horizontal to 1 vertical. Based on this DDESB acceptance, the Project Manager, Ammunition Logistics, at Picatinny Arsenal published a TDP which described methods for constructing three different types of geosynthetic reinforced barricades, using sandy soil as a backfill, as an improvement to ordinary sandbag walls. The TDP, reference AP2-4, provides detailed instructions for constructing a double-faced geotextile wall, a geotextile-wrapped sandbag wall, and a geocell wall. It was envisioned that these walls would be used in a Theatre of Operation, to protect and separate ammunition. However, use of these walls is allowed wherever permitted by DoD 6055.09-STD, for the reduction of separation distances (such as barricaded, intermagazine or barricaded, intraline). Painting of exposed portions of the two-geotextile walls has been found to be essential for barricade longevity.

4. **<u>4.2-Inch Mortar Rack</u>**. The 4.2-inch [107 mm] mortar rack is contained in a CONEX container and is built of wooden modules and steel plates, arranged in a specific configuration. Each module can contain one box of two M39A2 Composition B loaded mortar rounds. A steel plate is used to separate rows of modules.

A passive fire suppression system is used, which consists of plastic containers filled with a fire suppression liquid that are placed in select spaces in the rack. The sidewalls and roof of the CONEX must be sandbagged, and a door barrier must be constructed in front of the CONEX container. The 4.2-inch [107 mm] Mortar Rack was approved by the DDESB on 30 December 1991. If constructed and used in accordance with reference AP2-5, the MCE is one box of two mortar rounds. The rack requires a front QD of 310 feet [94.49 m] within a 30-degree arc (+/-15 degrees from the CONEX centerline) and a 100-foot [30.5 m] QD around the remainder of the storage site.

5. **Improved Loading Configuration for 8-Inch Artillery**. A 27 March 1987 DDESB memorandum approved loading configurations for TNT-filled 8-inch [7,874 mm] (M106) artillery ammunition, with associated propelling charges and fuzes, aboard transport vehicles. Transport vehicles using these approved spacing and shielding configurations are permitted to be parked near each other within a holding area, with the MCE considered one transport vehicle. Reference AP2-6 provides details regarding spacing, shielding, and load configurations that were approved.

6. **105 MM Tank Rack Design**. A rack was developed for the temporary storage of 105 mm tank ammunition in congested areas, such as when a tank has to be downloaded for maintenance. The rack is designed to limit the MCE to one tank round, which permits the application of a 50-foot [15.24 m] QD arc around the facility containing the rack. The facility has soil cover on its sidewalls, rear wall, and roof and uses a front barricade. The rack/facility design was approved by the DDESB on 23 December 1986. A modification of the initial approval, to add additional 105 mm ammunition types to those already approved to be placed in the rack/facility, was approved by the DDESB on 19 March 1987. Reference AP2-7 provides construction details for the rack, the facility that contains it, and identifies the 105 mm ammunition types permitted to be stored within it.

7. **105 MM/120 MM Tank Ammunition Download Rack**. Several construction options have been developed for the storage of 105 mm and 120 mm ammunition in facilities containing ammunition download racks that are designed to limit the MCE to one projectile only. These facilities use soil containment elements for the sidewalls, rear wall, and roof and have a front barricade. Reference AP2-8 provides the specifics for construction and use of the rack designs approved by the DDESB on 21 November 1989. The 105 mm versions of the rack require a 50-foot [15.25 m] QD, while the 120 mm versions of the rack require a 75-foot [22.86 m] QD.

8. **TOW Missile Rack**. A 28 April 1989 DDESB memorandum approved the use of the Tube-Launched, Optically-Tracked, Wire-Guided (TOW) Missile Rack. The rack, which limits the MCE to a detonation involving 50 pounds [22.68 kg] NEW (TNT equivalent), is contained within a CONEX container. The rack is assembled using stacking modules and steel plates between rows, in a manner similar to that described above for the 4.2-inch [107 mm] mortar rack. The CONEX container is sandbagged on the sides, rear, and roof, and a barricade is constructed in front of the

door. When assembled and used in accordance with reference AP2-9, the rack requires a front QD of 740-foot [225.52 m] within a 60-degree arc (+/-30 degrees from the CONEX centerline) and a 350-foot [106.68] QD is required around the rest of the container.

10. **Buffered Storage**. From 1986 through 1987, the Air Force conducted a series of tests to prove out the concept of "buffered storage", which used specific palletized AE material as a buffer between specified quantities (stacks) of Mk 82 or Mk 84 bombs, in order to prevent propagation between stacks and thereby reduce the MCE. The MCE was based on the NEW in the largest stack, plus the NEW of the buffer material (when HD 1.4 material is used as buffer material, then the HD 1.4's NEW does not need to be included). The QD was determined using the combined NEW. Test results are recorded in references AP2-10 and AP2-11. The Air Force received DDESB approval for use of the "buffered storage concept" in ECM, aboveground magazines, and at outdoor storage areas. A 30 April 1990 DDESB-KO memorandum approved 12 buffered storage configurations that were documented on Drawings AFISC 900402A through AFISC 900402L. Initially, the buffer material approved for use consisted of only palletized 20-mm, 30-mm, and CBU 58. DDESB-KT memorandum of 10 May 1990 authorized palletized CBU 71 to be used as a buffer material, and DDESB-KT memorandum of 28 November 1990 authorized the use of palletized CBU 52 as buffers.

11. **QD Reduction Using Concertainer Barricades**. TACOM-ARDEC Logistics R&D Activity, Picatinny Arsenal, sponsored the Munitions Survivability Technology program that developed and tested the use of a concertainer barricade for reduced MCE. A full-scale test of a HESCO-Bastion concertainer barricade, configured as shown in reference AP2-12, demonstrated its ability to prevent prompt propagation (sympathetic detonation) from occurring between munition storage cells, each containing 8,820 lbs [4,000 kg] NEW of Hazard Division (HD) 1.1, that were separated by less than the minimum barricaded intermagazine (IM) distance of 124 feet (K6) [38.80] [2.38], as required by C9.T5 of DoD 6055.09-STD. In the full-scale test, the barricaded IM distance provided between munition storage cells separated by HESCO-Bastion concertainer barricades was 28 feet. Detonation of a 8,820 lbs [4,000 kg] HD 1.1 donor charge located in the center storage cell did not cause any reactions to adjacent acceptor munition storage cells containing worst-case HD 1.1 and HD 1.3 munitions, though these munitions were scattered and damaged. Based on the results of this full-scale test, the use of a HESCO-Bastion concertainer barricade constructed per reference AP2-12 is approved, with a resultant reduction in required barricaded IM separation distance between adjacent storage cells from 124 feet (K6) [38.80] [2.38] to 28 feet [8.53]. The following pertain to use of reference AP2-12 for the storage of munitions:

1. Each storage cell is restricted to a maximum NEW of 8,820 lbs [4,000 kg] mixed HD 1.1 and HD 1.2 (Sensitivity Groups (SG) 1 through 5), HD 1.3, and HD 1.4. The maximum credible event associated with any storage arrangement constructed per the reference TDP is one munition storage cell and its QD is 1,250 feet [381 m], in accordance with Table C9.Tl. When determining NEW, HD 1.4 may be excluded, as it will not contribute to the severity of an explosion were one to occur.

2. A minimum of 10 feet [3.05 m] standoff will be maintained from the munition stack to the nearest concertainer barricade.

3. The height of the munition stack must be controlled to provide a minimum 2-degree angle from the top of the stack to the top of the barricade as illustrated in figure C5.F2.

4. The barricade length must meet the minimum criteria of DoD 6055.09-STD, as illustrated in figure C5.F3.

5. Inspection of the barricade will be conducted on a periodic basis to insure its integrity and stability. Deteriorating or damaged sections will be replaced.

12. **NATO QD Reduction Using Concertainer Barricades**

NATO Nations have conducted significant testing with these types of sand-filled, fabric, wire-reinforced (HESCO TM) barricades for the construction/protection of forward operating bases (FOB) used in deployed operational scenarios. This testing has shown that significant fragment protection (further enhanced with overhead protection), as well as some overpressure mitigation is provided by using these type barricades around explosives storage sites in order to reduce both internal (in camp) and external (off-base) QD. Based on this data, NATO developed AASTP-5, NATO Guidelines for the Storage, Maintenance and Transport of Ammunition on Deployed Missions or Operations (AASTP)-5 (reference AP2-13), which provides criteria associated with barricaded storage sites for up to 8,800 lbs (4,000 kg) and associated QD. The US has ratified AASTP-5 for use by US Forces in support of NATO operations. An accompanying document, reference AP2-14, was also developed to further explain the background data and protection levels associated with the field distances (FD) given in AASTP-5.

13. **Water Barriers to Prevent Prompt Propagation**

The Air Force has requirements to park combat aircraft at airfields in order to meet operational readiness requirements. These parked combat aircraft must comply with minimum airfield requirements and must be separated from each other by IMD (unbarricaded IMD is K11). Properly constructed barricades to defeat the low-angle, high velocity fragments may be placed between the aircraft to prevent prompt propagation and reduce the required separation distance to barricaded IMD (K6). The primary material that is used for such barricades is sand, frequently contained in HESCO bastions. While such barricades are effective, the HESCO bastions can deteriorate in harsh environments and must be replaced. Water has been shown to be an effective fragment mitigating material and several manufacturers make prefabricated blocks which can be filled with water and used to build walls.

Reference AP2-15 documents a test of a 0.5m (1.64 ft) thick and a 1.0m (3.28 ft) thick water barrier wall to determine if these walls will prevent prompt propagation. The water barriers were constructed of modular blocks that are a commercial off the shelf (COTS) item manufactured by MRP Systems Ltd., UK. The results of this test, therefore, are applicable only to water barrier walls constructed of the COTS modular blocks tested. The donor munitions were two MK 84 bombs and the acceptors were one MK 84 bomb and one AGM-65 Maverick Warhead on the other side of each wall.

Although, none of the acceptor munitions in the single wall scenario detonated or burned, the evidence of the fragment strikes on the acceptor munitions and witness panel make it inadvisable to utilize a single wall to prevent prompt propagation without further testing. There was no evidence of fragments from the donor bombs striking the acceptor munitions or witness panel on the double wall side, so it was therefore recommended that water barriers constructed using the MRP Systems Ltd.,UK, modular blocks in the 5 x 3 block configuration or larger be used in order to prevent prompt propagation between combat aircraft. Additionally, this test shows that the distance between combat aircraft separated by this 1.0 m thick water barrier need only be separated by K5 to prevent prompt propagation.

DDESB approval, and the conditions/limitations associated with the use of the modular blocks was given by DDESB-PD Memorandum of 27 September 2007, Subject: Water Barriers to Prevent Prompt Propagation.

14. **Reduced QD for F-15 and F-16 aircraft configurations involving AIM 7, AIM 9, and AIM 120 missiles**.

The U.S. Air Force conducted significant missile testing and missile-on-aircraft testing to determine associated MCE and QD for a number of F-15 and F-16 missile configurations. Based on this testing, DDESB-KT Memorandum of 5 May 2004 approved revised MCE and QD for those aircraft configurations listed in Table 1. The rationale on which DDESB approval was based is provided as part of reference AP2-16.

Table 2 provides the individual missile NEWQD used for determining required aircraft configuration MCE.

1. **Test Results**.

a. Table 3 shows the single missile HFD determined as part of the Air Force Test Program.

b. Tables 4 and 5 show the MCE for each aircraft configuration from Table 1 above. In some cases for the F-15, the configurations are broken down into cases based on missile configurations and/or positions.

2. **Final Quantity-Distance Determinations for Aircraft in the Open**.

a. Tables 6 and 7 show the Q-D determinations for aircraft in the open. The QD criteria presented in these tables are only for the aircraft and missile configurations described in Tables 1 and 2.

3. **Considerations for Aircraft in Buildings**.

1. Table 8 applies to aircraft configurations of Tables 6 and 7 when located in lightweight structures of the type described in the table. Where there is a question about whether or not a particular structure is considered lightweight and for structures of heavier construction, conduct a structural analysis per UFC 03-340-02 (reference 1-2) to determine the appropriate QD distance to apply.

4. **Tables**.

Table 1. Aircraft Configurations

F-16	
Configuration 1	4 AIM-120 missiles, 2 AIM-9 missiles
Configuration 2	2 AIM-120 missiles, 2 AIM-9 missiles, 2 AIM-7 missiles
Configuration 3	2 AIM-120 missiles, 4 AIM-9 missiles
Configuration 4	6 AIM-120 missiles
F-15	
Configuration 1	4 AIM-120 missiles, 2 AIM-9 missiles, 2 AIM-7 missiles
Configuration 2	4 AIM-9 missiles, 4 AIM 7 missiles
Configuration 3	6 AIM-120 missiles, 2 AIM-9 missiles

Table 2. Missile Configurations

Missile	**Missile NEWQD**	**Basis for Missile NEWQD**
AIM-120, WDU-33/B Warhead	16.9 lbs [7.67 kg]	Warhead NEWQD (15 lbs) [6.80 kg] plus some motor contribution.
AIM-120, WDU-41/B Warhead	19.0 lbs [8.62 kg]	Warhead NEWQD (16 lbs) [7.26 kg] plus some motor contribution.
AIM-9L, M, or X, WDU-17 Warhead	7.9 lbs [3.58 kg]	Warhead NEWQD only.
AIM-9P	10.5 lbs [4.76 kg]	Warhead NEWQD only.
AIM-7M, WAU-17 Warhead	36.0 lbs [16.33 kg]	Warhead NEWQD only.
AIM-7F, WAU-10 Warhead	26.1 lbs [11.84 kg]	Warhead NEWQD only.

Table 3. Test Results – Single Missile Hazard Fragment Distances

Missile	Single Missile Hazardous Fragment Distance (HFD)
AIM-120, WDU-33/B Warhead	280 ft [85.34 m]
AIM-120, WDU-41/B Warhead	335 ft [102.11 m]
AIM-9L, M, or X, WDU-17 Warhead	400 ft [121.92 m]
AIM-9P Warhead	400 ft [121.92 m]
AIM-7M, WAU-17 Warhead	280 ft [85.34 m]
AIM-7F, WAU-10 Warhead	199 ft [60.65 m]

Table 4. Test Results – F-16 Aircraft Configuration Maximum Credible Events

Configuration	Maximum Credible Event (MCE)[1,2]
Configuration 1 (4 AIM-120s, 2 AIM-9s)	One AIM-120 and One AIM-9
Configuration 2 (2 AIM-120s, 2 AIM-9s, 2 AIM-7s)	One AIM-9 and One AIM-7
Configuration 3 (2 AIM-120s, 4 AIM-9s)	One AIM-120 and Two AIM-9s
Configuration 4 (6 AIM-120s)	One AIM-120

Note 1: For each missile type, the missile configuration present with the largest NEWQD would be used for calculation of the NEWQD of the configuration MCE. For example, in Configuration 4, if 3 AIM-120, WDU-33/Bs and 3 AIM-120, WDU-41/Bs were present, the NEWQD for the Maximum Credible Event would be 19 lbs [8.62 kg] (the NEWQD of one AIM-120, WDU-41/B).

Note 2: HFD is based on the largest HFD of any single missile present.

Table 5. Test Results – F-15 Aircraft Configuration Maximum Credible Events

Configuration	Maximum Credible Event (MCE) [1,2]
Configuration 1 (4 AIM-120s, 2 AIM-9s, 2 AIM-7s)	
Case 1 – AIM-7s in Rear Fuselage Position	*Use whichever produces largest NEWQD:* One AIM-7 *or* One AIM-120 and One AIM-9
Case 2 – AIM-7s in Front Fuselage Position	One AIM-9 and One AIM-7
Configuration 2 (4 AIM-9s, 4 AIM-7s)	
Case 1 – AIM-7Ms in Front Fuselage Position, and any AIM-9Ps	Two AIM-9s and One AIM-7
Case 2 – AIM-7Fs in Front Fuselage Position	One AIM-7
Case 3 – Only AIM-7Ms, and only AIM-9Ls or 9Ms	One AIM-7
Configuration 3 (6 AIM-120s, 2 AIM-9s)	One AIM-120 and One AIM-9

Note 1: For each missile type, the missile configuration present with the largest NEWQD would be used for calculation of the NEWQD of the configuration MCE. For example, in Configuration 2, Case 2, if 2 AIM-7Fs and 2 AIM-7Ms were present, the NEWQD for the Maximum Credible Event would be 36 lbs [16.33] (the NEWQD of one AIM-7M).

Note 2: HFD is based on the largest HFD of any single missile present.

Table 6. Q-D for F-16 Aircraft in the Open

See Notes 1 and 2	NEWQD for MCE	HFD/IBD	PTR	IL	IM[3]
Configuration 1 4 AIM-120s, 2 AIM-9s	29.5 lbs [13.38 kg]	400 ft [121.92 m]	240 ft [73.15 m]	56 ft [17.07 m]	10 ft [3.05 m]
Configuration 2a 2 AIM-120s, 2 AIM-9s, 2 AIM-7Fs	36.6 lbs [16.60 kg]	400 ft [121.92 m]	240 ft [73.15 m]	60 ft [18.29 m]	10 ft [3.05 m]
Configuration 2b 2 AIM-120s, 2 AIM-9s, 2 AIM-7Ms	46.5 lbs [21.09 kg]	400 ft [121.92 m]	240 ft [73.15 m]	65 ft [1.81 m]	10 ft [3.05 m]
Configuration 3 2 AIM-120s, 4 AIM-9s	40.0 lbs [18.14 kg]	400 ft [121.92 m]	240 ft [73.15 m]	62 ft [18.90 m]	10 ft [3.05 m]
Configuration 4a 6 AIM-120, WDU-33/Bs	16.9 lbs [7.66 kg]	280 ft [85.34 m]	168 ft [51.21 m]	47 ft [14.33 m]	10 ft [3.05 m]
Configuration 4b 6 AIM-120s, with one or more being an AIM-120, WDU-41/B	19.0 lbs [8.62 kg]	335 ft [102.11 m]	201 ft [61.26 m]	48 ft [14.63 m]	10 ft [3.05 m]

Note 1: Configuration numbers do not correspond to configuration numbers in AFMAN 91-201.
Note 2: Unless otherwise specified,

- AIM-120s must be AIM-120, WDU-33/Bs and/or AIM-120, WDU-41/Bs
- AIM-9s must be AIM-9L, WDU-17s, and/or AIM-9M, WDU-17s, and/or AIM-9X, WDU-17s, and/or AIM-9P
- AIM-7s must be AIM-7M, WAU-17s and/or AIM-7F, WAU-10s

Note 3: This IM is based on the minimum aircraft separation requirement of 10 ft [3.05 m]. If circumstances require locating aircraft at less than this distance, then lesser IM distances may be approved by the Air Force.

Table 7. Q-D for F-15 Aircraft in the Open

See Notes 1 and 2	NEWQD for MCE	HFD/IBD	PTR	IL	IM[3]
Configuration 1, Case 1a 4 AIM-120s, 2 AIM-9s, 2 AIM-7Fs in Rear Fuselage Position	29.5 lbs [13.38 kg]	400 ft [121.92 m]	240 ft [73.15 m]	56 ft [17.07 m]	10 ft [3.05 m]
Configuration 1, Case 1b 4 AIM-120s, 2 AIM-9s, 2 AIM-7Ms in Rear Fuselage Position	36.0 lbs [16.33 kg]	400 ft [121.92 m]	240 ft [73.15 m]	60 ft [18.29 m	10 ft [3.05 m]
Configuration 1, Case 2a 4 AIM-120s, 2 AIM-9s, 2 AIM-7Fs in Front Fuselage Position	36.6 lbs [16.60 kg]	400 ft [121.92 m]	240 ft [73.15 m]	60 ft [18.29 m	10 ft [3.05 m]
Configuration 1, Case 2b 4 AIM-120s, 2 AIM-9s, 2 AIM-7Ms in Front Fuselage Position	46.5 lbs [21.09 kg]	400 ft [121.92 m]	240 ft [73.15 m]	65 ft [1.81 m]	10 ft [3.05 m]
Configuration 2, Case 1 2 AIM-7Ms in Front Fuselage Position, 2 AIM-7Fs or Ms in Rear Fuselage Position, 4 AIM-9s	57.0 lbs [25.85 kg]	400 ft [121.92 m]	240 ft [73.15 m]	70 ft [21.34 m]	10 ft [3.05 m]
Configuration 2, Case 2a 4 AIM-7Fs, 4 AIM-9s	26.1 lbs [11.84 kg]	400 ft [121.92 m]	240 ft [73.15 m]	54 ft [16.46 m]	10 ft [3.05 m]

Table 7. Q-D for F-15 Aircraft in the Open (Continued)

See Notes 1 and 2	NEWQD for MCE	HFD/IBD	PTR	IL	IM[3]
Configuration 2, Case 2b 2 AIM-7Fs in Front Fuselage Position, 2 AIM-7Ms in Rear Fuselage Position, 4 AIM-9s	36.0 lbs [16.33 kg]	400 ft [121.92 m]	240 ft [73.15 m]	60 ft [18.29 m	10 ft [3.05 m]
Configuration 2, Case 3 4 AIM-7Ms, 4 AIM-9Ls or 9Ms or 9Xs	36.0 lbs [16.33 kg]	400 ft [121.92 m]	240 ft [73.15 m]	60 ft [18.29 m	10 ft [3.05 m]
Configuration 3 6 AIM-120s, 2 AIM-9s	29.5 lbs [13.38 kg]	400 ft [121.92 m]	240 ft [73.15 m]	56 ft [17.07 m	10 ft [3.05 m]

Note 1: Configuration numbers do not correspond to configuration numbers in AFMAN 91-201.
Note 2: Unless otherwise specified,
- AIM-120s must be AIM-120, WDU-33/Bs and/or AIM-120, WDU-41/Bs
- AIM-9s must be AIM-9L, WDU-17s, and/or AIM-9M, WDU-17s, , and/or AIM-9X, WDU-17s, and/or AIM-9P, 10.5-lb [4.76 kg] Warheads
- AIM-7s must be AIM-7M, WAU-17s and/or AIM-7F, WAU-10s

Note 3: This IM is based on the minimum aircraft separation requirement of 10 ft [3.05 m]. If circumstances require locating aircraft at less than this distance, then lesser IM distances may be approved by the Air Force.

Table 8. Q-D for Table 13 and 14 Aircraft Configurations in Light Structures.

	IB	PTR	IL/IM
Fabric/Tubular Shelter or Light Metal Structure	Aircraft Configuration HFD [1]	*Note 2*	*Note 3*

Note 1: Minimum debris distance of 279 feet applies when in a light metal structure. No minimum debris distance applies to a fabric/tubular shelter.
Note 2: PTR is 60% of HFD.
Note 3: IL and IM distances are the same as determined for "open" in previous section.

15. **Approval of Reduced Maximum Credible Event (MCE) for AIM-9 and AIM-120 Mixed Trailer Configuration**.

DDESB-IK Memorandum of 10 February 2004 approved the reduced MCE for mixed storage configurations of two AIM-120 (any model) and two AIM-9 (any model) all-up missiles on an MHU-141/M missile transport trailer. The following conditions apply to this approval for use of a reduced MCE for AIM-9 and AIM-120 missiles on an MHU-141/M missile transport trailer:

a. The two AIM-120 missiles will be loaded only on the inside stations of the trailer, oriented in alternating directions to prevent warheads being located adjacent to each other. Ensure missiles are centered on trailer.

b. The two AIM-9 missiles will be loaded only on the outer stations of the trailer. The direction of the AIM-9s is optional. Ensure missiles are centered on trailer. Line-of-sight between the two AIM-9 missiles must be prevented while on the trailer.

c. The above placement will result in the two AIM-9 missiles (any orientation) being separated by two AIM-120 missiles (oriented in alternating directions).

d. The MCE for a trailer load meeting the above conditions is one AIM-120 missile and one AIM-9 missile, and the maximum allowable NEWQD for the trailer load, based on this MCE, is 29.5 pounds [13.38 kg] hazard division (H/D) 1.1.

e. The QD allowed for the subject trailer are as follows: IBD - 400 feet [121.92 m]; PTRD - 60% of IBD, which equates to 240 feet [73.15 m]; ILD - K18 [7.14]; and IM - 100 inches [2540 mm].

16. **Approval of MCE for Multiple All-Up-Round (AUR) Containers of AIM-7 Missiles with WAU-10 Warheads**.

Based on testing results documented in reference AP2- 17, DDESB-IK Memorandum of 30 September 2004 approved the establishment of the MCE, for stacks of multiple AIM-7 Missile (with WAU-10 Warheads) AUR containers, to be a single AUR container. The following pertain to this approval:

a. All four AIM-7 Missiles within the AUR container must be oriented in the same direction.

b. There are no restrictions on the orientation of AUR containers, relative to each other.

c. The NEWQD associated with an AUR container is 105 pounds [47.63 kg] HD 1.1. This is determined by using the MCE of a single AIM-7 (with a WAU-10 Warhead) as 26.1 pounds and multiplying it by 4, the number of warheads in an AUR container.

d. The QD associated with the AIM-7 (with WAU-10 Warhead) AUR container will be in accordance with paragraph C9.4.1.2.1.1.1 of DoD 6055.09-STD.

17. **Missile Container Storage Reduced Maximum Credible Event (MCE) for Air-to-Air Missiles**

DDESB-PD Memorandum of 25 April 2008 approved a single container MCE for a mixed storage configuration ofAIM-7, AIM-9 and AIM-120 air-to-air missile containers provided the following conditions are met:

a. Each stack of containers will contain the same type of missile and warhead.

b. Each stack will be no more than three containers high.

c. For containers of AIM-7 missiles with the WAU-10 warhead: (1) the missiles must be oriented in the same direction within the container, (2) there is no restriction on the orientation of the containers relative to one another within a stack, (3) there is no restriction on the orientation of containers between stacks, and (4) there is no required separation between stacks. MCE of the stack(s) is 105 lbs of HD 1.1 (based on the four warheads a single container).

d. For containers of AIM-7 missiles with the WAU·10 warhead: (1) the missiles must be oriented in the same direction within the container, (2) the containers within a single stack must be alternated (nose-to-tail), (3) there is no restriction on the orientation of containers between stacks, and (4) there is no required separation between stacks. MCE of the stack(s) is 144 lbs of HD 1.1 (based on the four warheads in a single container).

e. For containers of AIM-9 missiles with the WDU-l7 warhead: (1) there is no restriction on the orientation of the missiles relative to one another within a container, (2) there is no restriction on the orientation of the containers relative to one another within a stack, (3) there is no restriction on the orientation of containers between stacks, and (4) there is no required separation between stacks. MCE of the stack(s) is 32 lbs of HD 1.1 (based on the four warheads in a single container).

f. For containers of AIM-l20 missiles with the WDU-33/B warhead: (1) the missiles must be oriented in the same direction within the container, (2) there is no restriction on the orientation of the containers relative to one another within a stack, (3) there is no restriction on the orientation of containers between stacks, and (4) there is no required separation distance between stacks. The stack(s) is HD 1.2.1 with an MCE of 68 lbs (based on the four missiles in a single container).

g. For containers ofAIM-l20 missiles with the WDU-41/B warhead: (1) the missiles must be oriented in the same direction within the container, (2) there is no restriction on the orientation of the containers relative to one another within a stack, (3) there is no restriction on the orientation of containers between stacks, and (4) there is no required separation distance between stacks. The stack(s) is HD 1.2.1 with an MCE of 76 lbs (based on the four missiles in a single container).

h. Stacks of differing missile and warhead configurations will be separated from each other by a horizontal distance of 100 inches. (For example, stacks of AIM-7/WAU-I0 containers will be separated by a horizontal distance of 100 inches from stacks of AIM-7/WAU-17 containers.)

Provided the conditions above are met, the storage of mixed AIM-7, AIM-9 and AIM120 air-to-air missile containers (with the warheads specified above) may be sited based on whichever of the following is more restrictive:

(1) Siting the greatest MCE present as HD 1.1 (regardless of whether the greatest MCE is for HD 1.1 or HD 1.2.1), or

(2) Siting the total HD 1.2.1 NEWQD present.

18. **DDESB TP 15, Appendix AP1**.

Appendix AP1 provides four tables that provide extensive listings of magazines, primarily earth-covered magazines (ECM), which have been used over the years by DoD Components. Table AP1-4 will be of particular interest towards application to an operational field storage environment, because this table lists AE storage structures (aboveground and ECM) and containers that have been approved by the DDESB for specific NEW and provide for reduced MCE and/or reduced QD. The items in this table were generally designed for a particular application; however, as approved items, they can be used by other DoD Components and for other applications, provided all conditions, restrictions, design elements, etc., are observed. All documentation pertaining to the use of the storage structure or container must be obtained prior to their use. Table AP1-4 also identifies restrictions/conditions, as applicable, for use of the items listed.

19. **REFERENCES**

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AP2-11. Lewis, M. L. Jr., Friesenhahn, G. J., and Nash, P. T., "MK 84 Buffered Storage Test Series: PART I (Technical Report) and PART II (Data Report)," MMW-TR-87-50102AC, Southwest Research Institute Project No. 06-2067, Contract FA2650-87-D-0026, December 1988, conducted for Ogden Air Logistics Center, Hill AFB, UT.

AP2-12. Technical Data Package (TDP) for Quantity-Distance (QD) Reduction Using Concertainer Barricades, TACOM-ARDEC Logistics R&D Activity, Picatinny Arsenal, NJ 07806-5000

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AP2-14. NATO Working Paper, PFP(AC/326-SG/6)WP(2008)0001, “Assessment of the Field Distances Associated with the Operational Storage of Ammunition and Explosives of HD 1.1,” 8 May 2008.

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AP2-17. Technical Report “Hazard/Quantity-Distance-Test of AIM 7F/M and AIM 9L/M Missiles in All-Up-Round Shipping Containers,” MMWRM-TR-84-M25025C, Rev B, August 1985, Ogden Air Logistics Center, Hill, Air Force Base, Utah